



Figure 1. ADAPTHAUS rendering

## Introduction

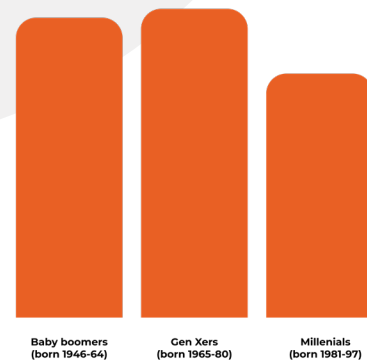
ADAPTHAUS, located on 1202 N Walnut Street in Champaign, IL, used sustainable housing design and cutting-edge technologies to meet the demands of our current environmental situation. This house brings a comfortable living experience and an adjustable space with minimal maintenance. Our architectural team used innovative modular housing design concepts to increase construction efficiency and safety, by following best practices and quality standards for modular construction to minimize site wastage. Moreover, modular housing construction decreases the project cost, project delay, and minimizes change orders.

We built a dynamic home to fit a

dynamic lifestyle and used space-saving techniques to create a single area that can serve many purposes. To keep the house affordable, it was built small, yet has all the necessities. The house can be expanded to suit the needs of individuals.

## Future Housing Trends

Homeownership at age 25-34



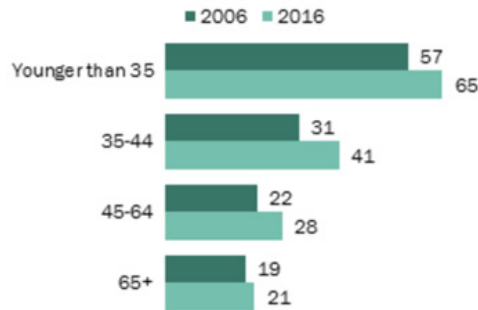
Source: The Urban Institute



Figure 2. Homeownership at age 24 - 34

## About two-thirds of households headed by young adults are rentals

% of household heads who rent their home, by householder's age



Note: Based on revised estimates.  
Source: Pew Research Center analysis of Census Bureau estimates of housing inventory.

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**Figure 3. Homeownership**

The US's current housing problem is the decline in homeownership in young adults due to rising housing prices and student debts. Most young adults cannot afford to buy a house early in their career, making rentals the only option. According to the Social Welfare History Project, most economically backward people spend half of their income on renting houses. The increasing cost of house rentals and frequent moving needs may drive young families deeper into debt. Another problem is overpopulation in large cities such as New York and Chicago, where owning a house soon after college is highly unlikely. As remote working is now the new standard, fewer people relocate to cities. In turn, individuals reside in more suburban yet well-established cities, such as Champaign. Therefore, the Illinois Solar Decathlon team set Champaign as our target demographic housing location and tried to understand the Champaign area's housing needs, aiming to improve the current residential housing industry and apply our design concept to other cities of similar population size.

## EXHIBIT 1 | Ten Trends Are Shaping What Future Types of Housing Will Look Like



Source: BCG analysis.

According to Boston Consulting Group, a few forces are transforming residential housing: sustainability, affordability, digital economy, construction methods, and building technology. Consumers' greater appreciation for sustainability and tighter regulations on energy consumption and green development spur the production of more eco-friendly housing options. Countries are changing their policies to achieve a "greener" earth. By 2018, 88 countries had mandatory or voluntary guidelines for building-related energy consumption or greenhouse gas emissions, compared to 38 countries in 1994. We forecast people's attention to sustainable housing options will increase dramatically in the next few years as more people are becoming environmentally conscious and realizing the seriousness of climate change.

The digital economy connects people worldwide via the internet, allowing them to shop, trade, pay or work merely using a computer or smartphone. The recent pandemic forced about 56% of workers to work remotely, yet 83% of employers now say the shift to remote working has been successful for their company, according to PwC's US remote work survey in 2020. These statistics show that remote working is becoming more popular, especially in the younger generation. Such trends increase interest in remote work, home offices, smart homes, and shared living, which aligns with our design's purpose.

Prefabrication is the future of construction methods. More residential home builders are using prefabricated building parts to improve productivity and reduce the project time frame. Our home design adapted modularization, a subset of prefab construction where parts of a structure are built in box-like portions. According to Skender, they can complete one module every two weeks per manufacturing line. The modules would be manufactured in their factory in an assembly line, not impacted by weather. However, this design aspect wasn't tested due to the pandemic, and the house was eventually constructed fully on-site. If a prefabrication method is applied to our design, a two-module unit could be completed within a month versus the stick-built timeframe of three months.

## Case Study - Champaign

Champaign county is a college town with a population of 209,689, according to the US Census Bureau. About 44,000 students live in Champaign county, and over 7,000 students graduate from the University of Illinois at Urbana-Champaign each year. About 66% of college graduates would stay in Illinois for their first destination. As young professionals leave their parents and start their own families, the total demand for housing is increasing exponentially.

The median home value in Champaign is \$158,700, which is significantly lower than the median home cost of \$205,400 in Chicago based on the US Census Bureau statistics. Only 22.2% of the Champaign houses were built after 2000, and most of them are over 30 years old. According to neighborhoodScout's data, an online database of hyper-local real estate data, the average annual home appreciation rate in Champaign for the past ten years has been just 0.84%, which is lower than 80% of US communities. Therefore, a change in the house design is desired. Although the construction cost for our project is more expensive than the median housing price, our house requires much less maintenance and includes unique features that make the house more energy-efficient and environmentally friendly. The unprecedented high project cost is also driven by the volatile material cost and increased labor costs due to the pandemic.

## Target Client

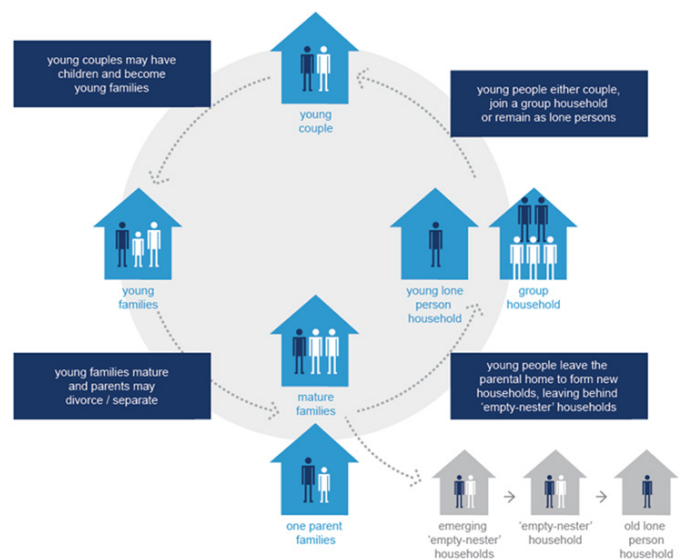


Figure 5

## Value

**\$158,700**

Median value of owner-occupied housing units

about three-quarters of the amount in Illinois: \$209,100  
about two-thirds of the amount in United States: \$240,500

### Value of owner-occupied housing units

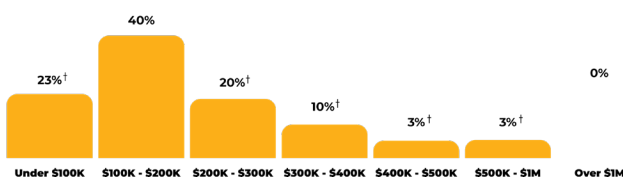


Figure 4



Characteristic or Requirement	ADAPTHAUS
Location of the permanent site	Champaign, Illinois
Client demographic	Young professionals
Household income	\$100,000

Our target clients are young professionals who have a few years of working experience and have some savings. We would also expect them to appreciate the sustainability and eco-friendly design when living in our house. Since the young professional's working lives are just beginning, we expect a lot of their time will be spent outside of the home, working. Therefore, ADAPTHAUS initially has one module, with a kitchen, bathroom, and bedrooms. With the first module cost of about \$301,000 and a young professional's estimated beginning salary of \$77,000, plus housing loans, they can easily afford the house with only a few years of professional/work experience. This option provides more stability and security compared to an unknown future and provides a family with more than one outlet to grow.

Stages	Module 1	Module 2 Addition	Module 3 Addition
Scenarios	A Single Young Professional	A family with no children	Entire family with two children
Cost	\$205,401	\$90,325	\$90,325

The expandable modular housing design feature allows for more flexible and affordable upgrades, instead of tedious journeys to find the next livable housing in the old-fashion housing hunting process. These modules are meant to

be accommodating as our target clients reach different milestones in their lives. As the young professional grows older and meets his or her future partner, together, they may purchase the second unit for an additional \$92,963, which would bring them an additional living room and a bedroom or study space. The 1,200-square feet house is the average housing size in Champaign and should bring them more than enough living space. A couple of years later, the couple may become parents and their children would require private spaces or more living space. They can then purchase the third module as their children's room and study. With the sustainable features, this home possesses, the child would live under the influence of his parents who care about the environment. When the children grow up and leave their parents, the third modular can be easily modified to an Airbnb room and provide additional income for the parents. As the children move on through adulthood, they may look for similar housing options as their parents did.

## Livability

The 'ADAPTHAUS' project's main purpose, apart from participating in the Solar Decathlon competition, is to provide a future housing solution in the Champaign area that can house a family throughout its lifetime and uplift the neighborhood with its unique beauty. After completing the project, the house will be donated to Habitat of Humanity, a non-profit organization who will match a couple to the house. The design of the 'ADAPTHAUS' project is formulated with an emphasis on providing the means for an eco-friendly lifestyle. The inclusion of the canopy not only provides a sufficient shelter spot for its residents but can also be used for decorative purposes to uplift the residents' mood. The modular, flexible units are designed to prioritize

convenience for residents by giving them the ability to adapt the units for their ongoing needs and to limit their amenity costs without compromising the living conditions. The house's location allows for ideal living conditions, as it is located near schools, parks, and it is less than a mile away from Downtown Champaign, where a family can fulfill all of their basic needs. A five-minute walk to nearby bus stops provides affordable access to the greater Champaign-Urbana area. In addition to its great location, the house is designed to support upscaling and downscaling of its units, so that its residents can optimize the extent of their comfort with relation to their necessities. Lastly, the house is designed and constructed under ADA regulations to ensure the safety and convenience of its residents.

The design of the house's lighting is aiming to fulfill the residents' needs by using prefabricated light entry glass doors and windows to provide adequate lighting. The house's living room has a large interior that provides the means for entertainment activities. Its modular-based design allows for greater resident control. The design focuses to provide an energy-efficient lifestyle including off-the-grid capabilities for a family-size home. Other appliances to be installed within the house include a Beko energy star refrigerator, nature's head composting toilet, thermostat, smoke alarms, washer/dryer, WAC LED lightings, air-conditioning, and heating unit components.

The design of 'ADAPTHAUS' encourages a homeowner to use fewer resources than a typical homeowner because of its implementation of low maintenance components that severely reduce operating costs. Furthermore, the house's roofing will include solar panels that will essentially transform it into a net-zero energy home.

## Buildability

The current housing market is prone to using the traditional stick-built technique. However, ADAPTHAUS adapted a modular home design concept, where the entire house can be broken into equal-sized modules with 80% of each module completed in the manufacturer's factory, then shipped to the site for final connection to the foundation and Mechanical-Electrical-Plumbing (MEP) connections by local homebuilders. The homeowner can decide to add any additional modules to the previous design based on his or her needs. Such a modular design can be 20% cheaper than regular stick-built houses, much more precise in dimensions, at less risk to be affected by bad weather, and its cost and schedule can be much more predictable.

In our initial structural design, we used steel framing for the house, currently very rare even in the modular housing industry. Whereas the steel framing can support a much higher load than the regular wood framing, which makes modular high-rise (up to 12 floors or more) housing possible. Our initial partner, Skender predicted that a single module can be completed within a week per manufacturing line once their equipment is put in place. Given the proper design and construction documents, this project should have no issue with buildability because manufacturers have experience working with the framing of the house. The only portion that might be new to them is the interior design and interior product selection. For local home builders, they should have no issue constructing the foundation and connecting the MEPs.

Unfortunately, Skender closed down their factory because of the COVID-19 pandemic and the economic downturn, which ended our partnership with them. Our team quickly redesigned the housing framing to wood and changed the construction method to stick and build to

meet the competition deadline. The more time is available, we would still favor the modular housing concept.

Additionally, this project includes environmentally friendly features that are energy-efficient, and are commercially available though have not been prevalent in the residential housing industry. Our design aims to promote sustainable design to the current housing market and meet our target client's preference for better technology and "greener" housing design. We believe this project is another living proof that modular housing is affordable and constructible. We hope that this project can be set as an exemplar to the housing market inspiring more homebuilders to adopt such a design.

## Value to the target client

The goal of the ADAPTHAUS project is to provide sustainable housing and cutting-edge technologies that are not only economically feasible in Champaign, Illinois but also create a housing design that can meet the future needs of young professionals who care for energy usage and the environment nationally. One of the key ideas is to eliminate the need to move; as an individual's spatial needs change throughout their life. Constructing a new house requires more materials and space, creating more waste and negative impacts on the environment. Certified sustainable building materials such as reclaimed wood and recycled insulation are utilized to maximize energy-saving efficiency and minimize the carbon footprint from material production. The mechanical, electrical, and plumbing components of ADAPTHAUS are designed with home automation systems, cutting-edge technologies, and smart material choices allowing them to reduce energy consumptions and work as efficiently as possible. An area of

improvement within the solar industry is to have better battery waste disposal practices. Our attempt in combating this is by using a repurposed lithium-ion battery storage pack that reduces our system's life cycle impact. The landscape-direct greywater design featured in ADAPTHAUS would be the first application of its kind in the state of Illinois, which allows the homeowner to reuse the water on-site. This reduces the burden on the water treatment facility, where they could use that energy for other purposes. Additionally, we estimate annual water savings of \$33. Our project shows that sustainable construction is attainable on a small scale.

ADAPTHAUS is designed to accommodate the ever-changing natures of living experiences throughout different stages of life. The idea of a modular house system gives the homeowner the ability to purchase the housing units based on their current needs and budget constraint. Multiple space-saving techniques are emphasized throughout the living areas allowing them to be used for various functions during different times of the day, optimizing the energy and operating costs. ADAPTHAUS' design is ADA compliant to ensure the safety and convenience of all-ages. The house encourages the residents to use fewer resources than average home residents in view of its implementation of low maintenance components that significantly reduce operating costs.

ADAPTHAUS aims to provide sustainable housing at an affordable price for our target consumer of young business professionals. As remote working is becoming standard business practice, staying in Champaign or other suburbs yet well-established cities are getting more and more popular. According to a survey conducted in Champaign county, the surrounding area of ADAPTHAUS, approximately 66% of college students would stay in the area after graduation. Two of the main causes is the high cost of living

and overcrowding in large cities. In our case study, the median home cost in Champaign is significantly lower than the median home cost in Chicago. Additionally, the homeowner will benefit from the modular housing construction that is 20% cheaper than a regular ground-up construction while offering a shorter building timeline, less risk of project delay, better house quality, and more financial flexibility. According to Skender, ADAPTHAUS' initial partner, a single module can be completed within a week per manufacturing line. ADAPTHAUS's idea will revolutionize the single-family housing industry in the near future.

